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BIOMASS ANALYSES FOR FOUR AREAS IN THE TENNESSEE VALLEY REGION

Division of Land and Economic Resources
Office of Natural Resources and Economic Development
Tennessee Valley Authority
Norris, Tennessee 37828

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BIOMASS ANALYSES FOR FOUR AREAS IN THE TENNESSEE VALLEY REGION

Abstract

Analyses for four biomass procurement areas in the Tennessee Valley are presented. The Marlow and Perryville, Tennessee, sites can provide 38,000 dry tons of industrial residue annually. Mulberry Creek, Alabama, and Watts Bar, Tennessee, can annually provide 330,000 dry tons of industrial residue and/or forest biomasss. Methanol can be produced at the Perryville and Marlow sites and ethanol at Mulberry Creek and Watts Bar.

By

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BIOMASS ANALYSIS FOR FOUR AREAS IN THE TENNESSEE VALLEY REGION

INTRODUCTION

This report analyzes forest biomass resources for alcohol production for four procurement areas in the Tennessee Valley. The forest biomass resource includes wood and bark material from the forest, and from forest industry residues. The amounts of biomass that can be obtained and its approximate delivery cost are also given. The data will assist managers in locating new biomass-using plants in the Tennessee Valley.

Biomass is plentiful. Current estimates show that each year 230 million green tons are available in the United States--and 25 million green tons are available in the Tennessee Valley[1]. This is enough to meet the production requirements of any biomass plant discussed in this report.

There are two options for biomass procurement. One option is to contract with an independent company to acquire and deliver the biomass. The other option is for the biomass-using facility to have its own procurement staff. Both options have advantages and disadvantages which are discussed in this report. Figure 1 shows the location of the small facilities manufacturing methanol, Marlow and Perryville, and figure 2 shows the location of the larger facilities manufacturing ethanol, Mulberry Creek and Watts Bar.

DISCUSSION

The Forest Resource Base

The forests of the Tennessee Valley are a renewable energy resource. Thirty million acres--51 percent of the area--are forested and 79 percent of

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[1]The Tennessee Valley Authority is continually revising biomass estimates as new data are obtained. Thus the biomass data appearing in this report may differ from data published prior to or after this report.

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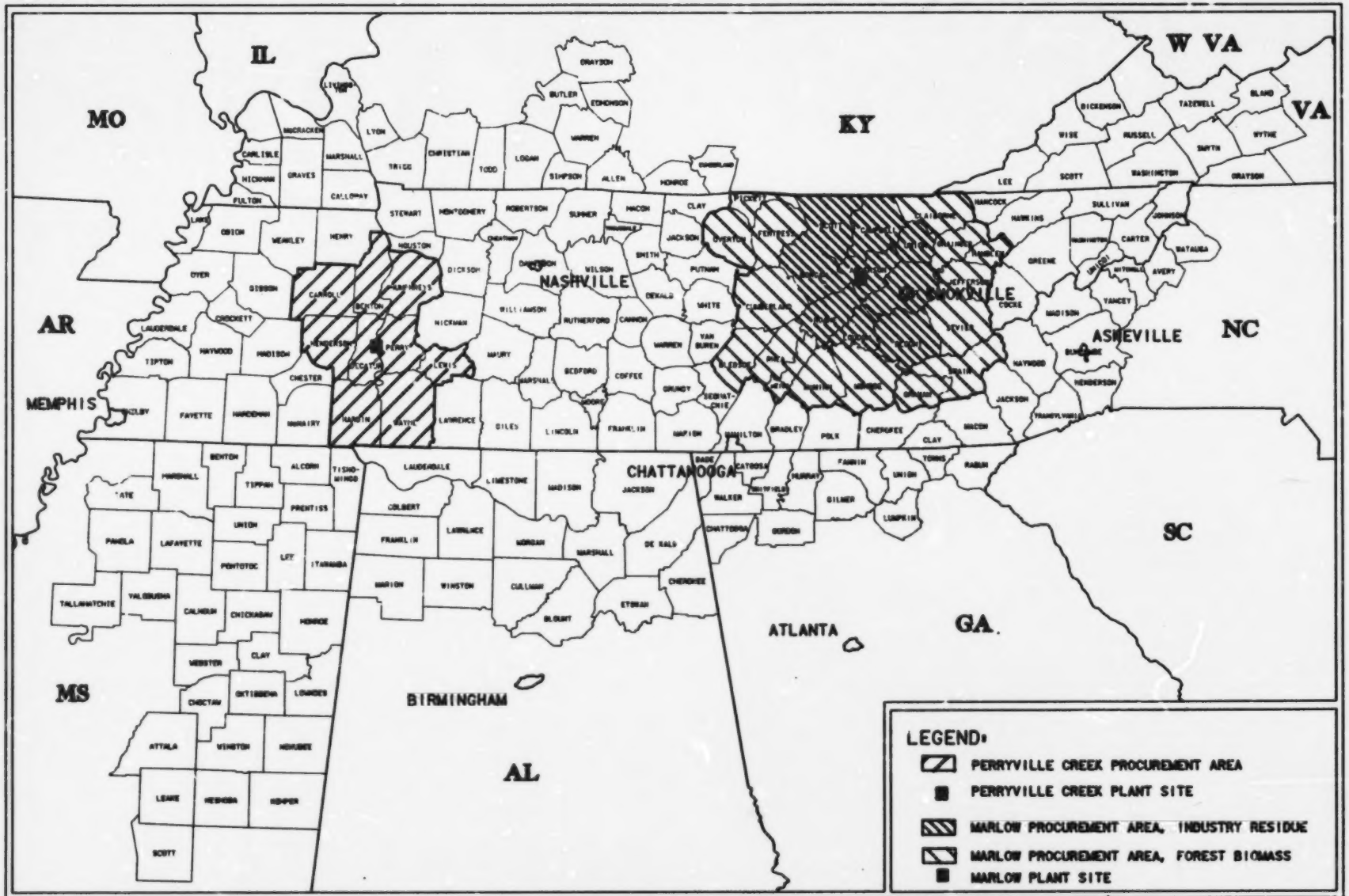

Figure 1. Plant site and procurement area for small biomass-using facilities Perryville and Marlow, Tennessee

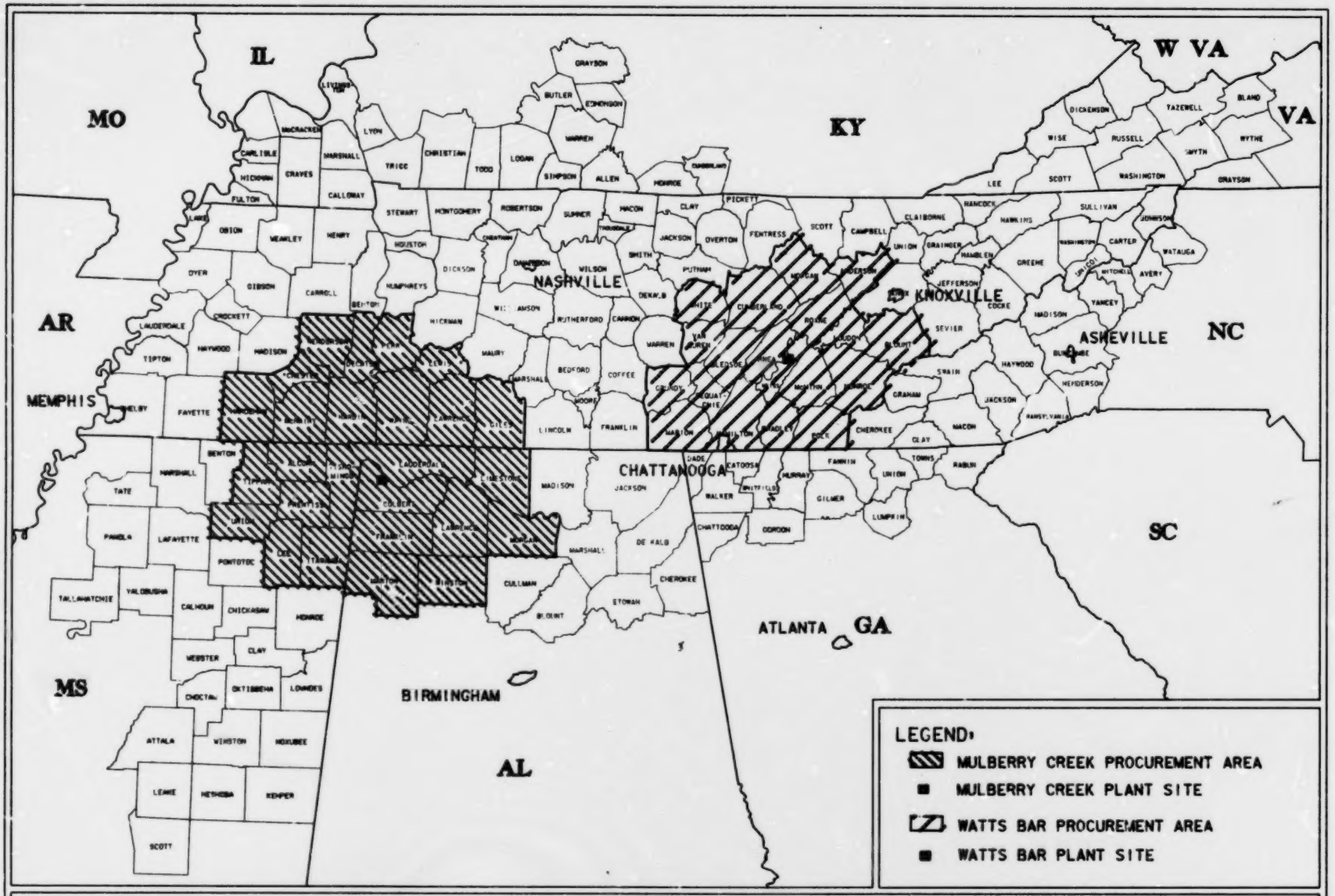

Figure 2. Plant site and procurement area for large biomass-using facilities Mulberry Creek, Alabama, and Watts Bar, Tennessee

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the forest is hardwood. The weight of all the trees is approximately 1.3 billion dry tons, and the weight increases 2.5 percent annually. Trees are growing three times faster than they are being cut. In fact, the 201 counties that make up the Tennessee Valley area are estimated to have an annual surplus of 14 million dry tons--25 million green tons of biomass.

Procurement

Plans for procuring biomass differ depending upon the amount of biomass needed, the kind of forest and forest industry in the area, and the expected delivered cost of the biomass.

The cost of delivered biomass is influenced by many factors. Moisture content (MC) of the biomass, the size of the procurement area, the method of transportation used, and the unloading system are a few of the factors. Other factors affecting the price of forest biomass are terrain, forest ownership, harvesting systems, and forest composition. Single tree selection, clear cutting, and clean cutting harvesting methods affect the cut per acre and the economics of each cutting method. Harvesting the forest resources in the mountains is more costly than harvesting on flat terrain. Harvesting costs are also greater when individual trees are harvested than when groups of trees are harvested, and clean cutting is the least expensive of all harvesting methods because all trees of all sizes are harvested. And acquisition from lands owned by many people is more expensive than from a single owner.

As mentioned earlier, the biomass plant managers have two options for wood procurement. The first option is to engage the services of a wood broker, while the second is to have an in-house procurement organization.

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There are two types of wood brokers in the Tennessee Valley. One is called a "dealer," and is widely used by the pulp and paper industry to arrange the delivery of roundwood (i.e., pulpwood or other forest products). As specified by the contract, dealers provide all or most of the following services: the acquisition of stumpage and harvesting rights from owners, arrangements for harvests, the delivery of wood as specified in contract, and financing harvesting operations to ensure that the system works smoothly.

Since the oil embargo of 1973, the second type of broker, the wood residue broker, has become increasingly common. These brokers provide the same basic services as the roundwood dealer, although they handle only industrial wood waste. Though fewer in number, these brokers service larger areas than roundwood dealers.

Using a broker system frees the operating company of the responsibility of biomass procurement. The broker provides a long-term contract for delivering the biomass and day-to-day problems are handled by him. He knows how to communicate with residue producers, which is important because currently not all of the wood residue suppliers have a written contract. For those suppliers who have contracts, the contracts are usually for one year, while a few are for as long as five years.

The other procurement option is for the facility to set up its own in-house procurement system. This system must provide the services mentioned earlier in this section; however, under this option they are provided by the company. Since it is difficult to obtain long-term contracts for industrial wood residues, initial financing to construct a biomass-using facility may be difficult because most lenders prefer that companies have long-term contracts for raw materials. Brokers can provide long term biomass contracts, even though residue suppliers will not.

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The Four Sites

The four proposed sites are located in the Tennessee River Vall The procurement area for Marlow (figure 1), small site for methanol, overlaps the procurement area of Watts Bar, large site for ethanol, and Perryville overlaps Mulberry Creek (figure 2). This overlapping will not influence the conclusions of this report. The forest resources and industry residues in a procurement area in this study will not have deductions made for other procurement areas that overlap. This is a customary procedure for making resource analyses because investors of resource projects will space plants to minimize resource procurement problems.

There have been changes in a few ownerships and in total numbers and production levels of forest industry plants in all four procurement areas, but the data is the latest and best available. Also, the Tennessee Valley Authority (TVA) will do current resource and residue surveys for serious investors who need the 1979 data updated. The 1979 canvass was done by TVA with assistance by State Divisions of Forestry personnel for Alabama, Mississippi, and Tennessee. All forest products data in this report are based on this survey.* Also all residue and forest biomass data are given in oven-dry tons (zero moisture content) unless otherwise noted.

The Perryville Site

The Perryville (methanol) site is located in West Tennessee on the west bank of the Tennessee River. The nine counties (appendix, table A) in the 30-mile procurement area have 116 forest products firms that produce 426,000 dry tons yearly of industrial residues of which 119,000 dry tons are unused.

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*Brooks, R. T., J. D. Perry, and S. J. Byrne. "Production and Use of Industrial Wood and Bark Residues in the Tennessee Valley, 1979" (Norris, Tennessee, April 1981), 127 pp. TVA Technical Note B45.

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The procurement area has 1.9 million acres of commercial forest land. Hardwood trees grow on 85 percent of the forest land, a mixture of pines and hardwoods grow on 7 percent of the forest land, and pines alone grow on 8 percent (appendix, table A). The total aboveground weight of trees 5 inches in diameter breast height (d.b.h.) and larger, called growing stock, in the 9 counties is 77 million dry tons. The net annual increase is 1.7 million dry tons (appendix table B gives 2.9 million green tons) of which the biomass plant can use only 38,000 dry tons.

Industrial residues plus the forest resources provide 48 times the biomass needed at Perryville. See appendix tables B and C, and the summary table below.

Industrial Residues, Annual Dry Wt.		Forest Biomass, Annual Dry Wt.	
Item		Item	
Produced, Tons	436,000	Total weight, Tons	76,504,000
Used, Tons	317,000	Net change, Tons	1,693,000
Unused, Tons	119,000	Percent change	2.2
Plants, Number	116		

Table 1. Summary of Industrial and Forest Residues, Perryville Site.

The major use of residues in this area is for industrial fuel followed by wood pulp and domestic fuel. These three uses comprise 98 percent of the residue used.

The Marlow Site

The Marlow (methanol) site is located near Oak Ridge and is 24 miles west of Knoxville, Tennessee. The nine counties listed in appendix table D are in the forest resources procurement area which has a 30-mile radius. The industrial residue procurement area contains 25 counties in a 60-mile radius. There are 276 firms in this 60-mile area that produce 475,000 dry tons of residue of which 73,000 dry tons are unused.

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There are 1.5 million acres of commercial forest land in the 9-county forest resources procurement area. Sixty-nine percent of the forest is hardwoods, 18 percent is softwoods, and 13 percent is mixed pine-hardwoods (appendix table D). The total aboveground weight of trees 5 inches in d.b.h and larger is 70 million tons. The weight of the growing stock is increasing 2.3 percent annually, 1.6 million dry tons (appendix table B gives 2.9 million green tons).

Industrial residues plus the forest resources provide 45 times the biomass needed at Marlow. See appendix table E and the summary table below.

Industrial Residues, Annual Dry Wt.		Forest Biomass, Annual Dry Wt.	
Item		Item	
Produced, Tons	475,000	Total weight, Tons	70,284,000
Used, Tons	402,000	Annual change, Tons	1,630,000
Unused, Tons	73,000	Percent change	2.3
Plants, Number	276		

Table 2. Summary of Industrial and Forest Residues, Marlow Site.

The major uses of residue are: industrial fuel 219,000 tons and woodpulp, 54,000 tons. Metallurgical chips, domestic fuel, and other uses amount to 129,000 tons.

In summary, there are enough industrial residues produced in the 25 counties that compose the Marlow residue procurement area to provide for the needs of the proposed biomass-using facility. The average delivered price of the residue may rise from $13.20 to $15.00, which will influence some residue suppliers to switch from their old customers to the new plant. Other suppliers will switch because the new plant is closer. The residue acquired from these changes plus the 73,000 tons of unused residue reported is adequate for production needs.

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The Mulberry Creek Site

The Mulberry Creek (ethanol) site is located in Colbert County, Alabama, on the Tennessee River (figure 2). There are 26 counties in the biomass procurement area, which includes counties in Alabama, Mississippi, and Tennessee.

There are 380 forest products firms in the area that can provide 389,000 dry tons of residue annually--more than enough for any proposed facility.

The area has a 65-mile radius and contains 5.1 million acres of commercial forest land. Hardwoods grow on 66 percent of the forest land, mixed pine-hardwood grows on 14 percent, and pine grows on 20 percent (appendix table F).

The aboveground weight of the forest resources is 186 million dry tons, and is increasing 3.9 million dry tons annually, 2.1 percent. This increase is 13 times the amount of resources needed to supply 330,000 dry tons (appendix table B gives 6.9 million green tons).

Industrial residues plus the forest resources provide 13 times the biomass needed at Mulberry Creek. See appendix table G, and the summary below.

Industrial Residues, Annual Dry Wt.		Forest Biomass, Annual Dry Wt.	
Item		Item	
Produced, Tons	1,138,000	Total weight, Tons	186,049,000
Used, Tons	749,000	Annual change, Tons	3,913,000
Unused, Tons	389,000	Percent change	2.1
Plants, Number	380		

Table 3. Summary of Industrial and Forest Residues, Mulberry Site.

The major use of industrial residues is industrial fuel, 45 percent; followed by pulp, 26 percent; and miscellaneous uses, 12 percent. The remaining 17 percent is used for domestic fuel, fiber and metallurgical purposes.

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Watts Bar Site

The Watts Bar (ethanol) site is located in Rhea County at Tennessee River mile 520, between Knoxville and Chattanooga, Tennessee (figure 2). All nineteen counties in the procurement area are Tennessee counties.

There are 3.2 million acres of forest land in the procurement area which is 63 percent hardwood type, 22 percent softwood type, and 15 percent mixed type (appendix table H). The total aboveground weight of growing stock trees is 136 million dry tons and is increasing 2.6 million dry tons per year (appendix table B gives 4.6 million green tons).

Since there are only 56,000 dry tons of unused residues available, an additional 274,000 tons of biomass must be obtained. Tree length pulpwood is available for $19.45 per dry ton.

Industrial residues plus the forest resources provide 8 times the biomass needed at Watts Bar. See appendix tables B and I, and the summary table below.

Industrial Residues, Annual Dry Wt.		Forest Biomass, Annual Dry Wt.	
Item		Item	
Produced, Tons	382,000	Total weight, Tons	136,447,000
Used, Tons	326,000	Annual change, Tons	2,620,000
Unused, Tons	56,000	Percent change	1.9
Plants, Number	217		

Table 4. Summary of Industrial and Forest Residues, Watts Bar Site.

The major uses of the industrial residues are 56 percent for industrial fuel, 15 percent for pulp, and 14 percent for miscellaneous uses. Minor residue uses include fiber, metallurgical and domestic fuel totaling 15 percent.

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An Analysis of Biomass Procurement for the Four Sites

The biomass needs of the small and large facilities are so different--122 tons per day versus 1,000 tons per day--that small procurement areas can only be compared to other small procurement areas, and large areas can only be compared to other large areas.

Small Procurement Area Analysis

There are important similarities and differences between the Perryville and Marlow areas. Both areas have nine counties in the 30-mile radius procurement area, nearly the same amount of annual change of forest resources, and nearly the same amount of industrial residue produced. Both are in the pulpwood procurement area for a pulpmill, and both have the Tennessee River splitting its procurement area. Their differences are the terrain, the size of the residue procurement area, and the amount of industrial residue reported as unused. These differences are the causes of different delivered residue prices for the two areas. A discussion of these areas follows.

The Marlow area does not have the excess of industrial residues as does the Perryville area so residue prices may increase. There are four reasons for the possible price increase. First, there are more residue suppliers which increases the unit cost of delivered residues; second, the terrain is more adverse; third, there is less of an excess of residue which may force prices up; and fourth, there are more buyers than at Perryville.

Some future price estimates, based on 1982 prices, can be made based on current information, residue price movement from previous years, and an understanding of how forest product managers react to new buyers entering the market. The base price for delivered residues is estimated

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to be $13 per ton at Marlow. This is the current price residue users are paying for an average load of 12 tons of dry residue shipped about 30 miles. The additional demand of 38,000 dry tons represents a shift in the demand curve. This shift indicates a price increase to about $15 in the Marlow area, and a reduction in the amount of unused residues to 35,000 dry tons. Residue producers will begin to shift from established customers, who are paying the old price of $13, to the new customer who must pay the new price of about $15 to obtain 38,000 tons of residue. Some residue suppliers will sell to the new plant because it is convenient. In summary, the price of biomass should not increase at Perryville, while at Marlow a small price increase is predicted.

Large Procurement Area Analysis

The Mulberry Creek, Alabama, and the Watts Bar, Tennessee, procurement areas have similarities as well as differences. The similarities are that both areas are in a pulpmill wood procurement area and both have the Tennessee River flowing through them.

The differences are that the Mulberry Creek area has 26 counties with 5.1 million acres of forest land while the Watts Bar procurement area has 19 counties with 3.2 million acres of forest land and that the net annual change of growing stock in the Mulberry Creek procurement area is 3.9 million dry tons, while the change in the Watts Bar procurement area is 2.6 million dry tons. However, the one difference that has the greatest price effect is the amount of unused residues from the forest products firms. The Mulberry Creek area has 389,000 dry tons, while the Watts Bar area has only 56,000 dry tons.

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In addition to these differences, the use of industrial residues in the Mulberry Creek area will increase substantially within the next 4 years. The city of Hohenwald, Tennessee, has announced its intent to build a wood-fueled energy system and the Tennessee River Pulp and Paper Company, Counce, Tennessee, is now constructing a steam generating facility which, together with Hohenwald, will use 730,000 tons of wood each year. When these facilities go online Watts Bar would be the first choice between the two proposed biomass-using sites.

The 380 forest products firms in the procurement area can provide 100 percent--330,000 dry tons--of the large facility's biomass requirements. Thus, there should be no significant procurement problems at this site. The price of industrial residues here is estimated to be $18 per ton or $5.9 million per year for the required tonnage of residues.

The recommendation for the Watts Bar ethanol plant is to purchase industrial residues and tree-length pulpwood for making ethanol. There are only 56,000 dry tons of unused residues in the Watts Bar area that can be used for making ethanol. An additional 274,000 dry tons will be needed and these additional amounts will come from the same biomass sources as in the Mulberry Creek area--tree-length pulpwood, sawmill chips, and whole-tree chips. The least expensive biomass (in dry tons) is industrial residue at $18 per dry ton, and the next cheapest is tree-length pulpwood at $19 per dry ton. The annual cost of the industrial residue is $1.0 million and the cost of the 274,000 tons of tree-length pulpwood is $5.2 million for a total cost of $6.2 million.

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Other Considerations

Tree-length pulpwood must be chipped before it can be used. The equipment to do this costs $12 million and its operating and maintenance cost is estimated to be $10 per ton. The exact per ton cost can only be determined by an engineering study, which is beyond the scope of this paper. The cost per ton of biomass obtained from tree-length pulpwood may be more expensive than other forms of biomass if the operating and maintenance cost of the equipment were allocated to the biomass cost and not to other production stages.

The procurement staffs at the Mulberry Creek and Watts Bar plants will need to plan their biomass pricing policy or the price of residues (figure 3) and the price of tree length pulpwood will tend to rise. The biomass prices in both areas, from the lowest to the highest, are industrial residues, tree-length pulpwood and sawmill chips. If residue prices are not set before purchasing begins, prices will rise as the plant procurement staff tries to obtain 330,000 dry tons per year from areas where industrial residues supplies are tight. Figure 4 shows the price rise from P to P_1. In parts of North Carolina biomass is now $30 per dry ton.

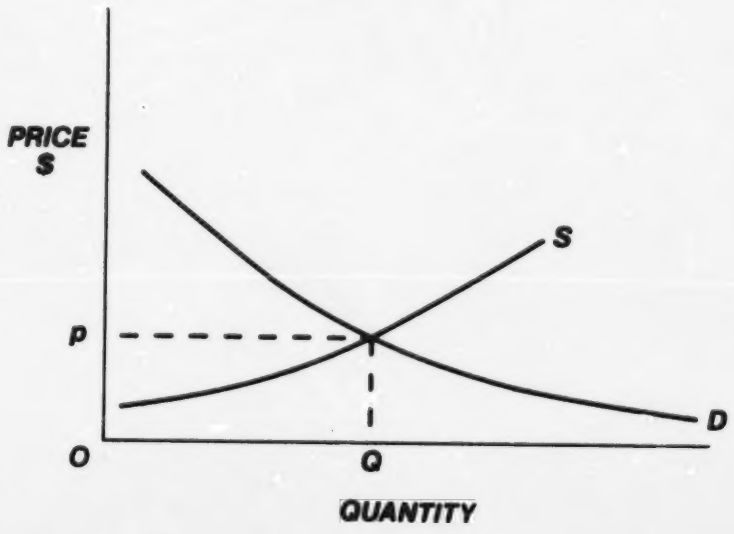

Figure 3. Supply curve. A typical residue supply (S) and demand (D) curve before a large residue user enters the area.

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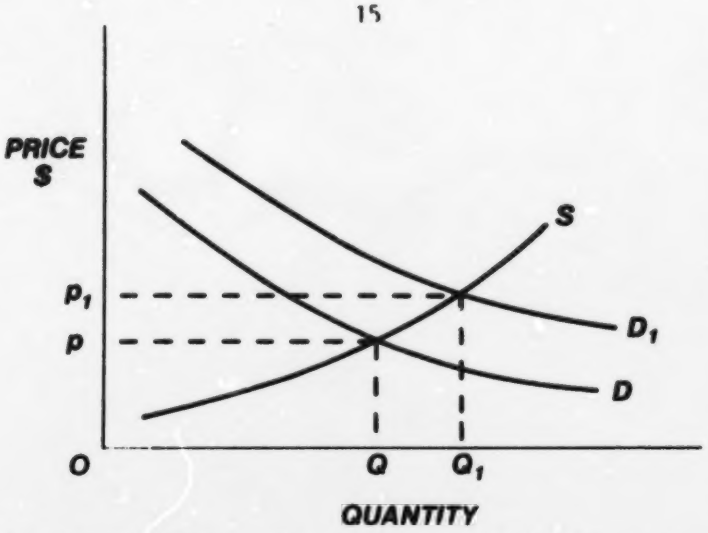

Figure 4. Demand curve. The new demand (D_1) curve has moved to the right of D. The intersection of S and D, indicate a price (P). As long as there is a demand of D_1, there cannot be a price of P unless new supplies are introduced in the market.

The fact is the biomass needs of a large facility are so great that its entry into the market place will cause a disruption of local prices so the demand curve shifts to the right. A demand curve, D, chat shifts to the right, D_1, means a higher price has been set (see figure 4). It is the opinion of TVA's Forest Industry Development Project personnel that after an informal analysis was made of the uses of biomass in these two areas, that an unregulated or free-market price for biomass in the Mulberry Creek and Watts Bar procurement areas would be between $24 and $26 per dry ton. This is still below the reported $30 per dry ton price of residue in North Carolina, but $6 to $9 above the average residue price now reported in both procurement areas. The biomass price can be kept at or near its original level by creating new supplies of biomass which also causes the supply curve to shift to the right (see figure 5). The intersection of the new supply curve S_1 and the new demand curve D_1 is at or near the same price as the "old" price. The new biomass supplies will come from tree-length pulpwood.

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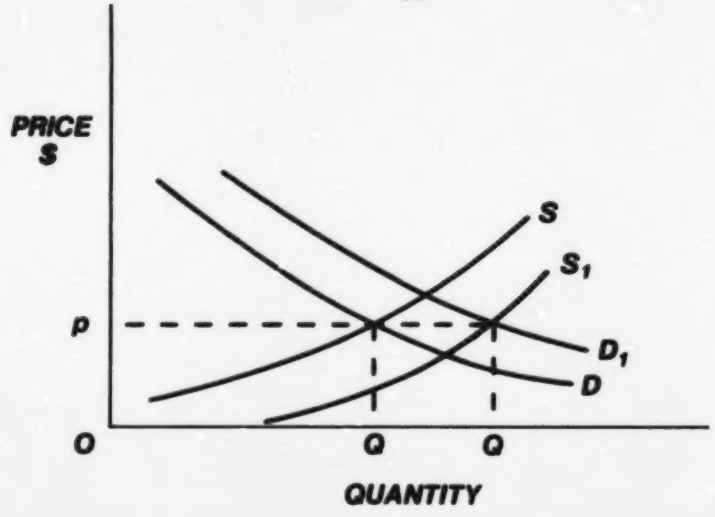

Figure 5. Supply curve. The new supply of biomass has shifted the supply S curve to S_1. It intersects D_1, near the original price P.

CONCLUSION

The conclusions are based on the assumption that the biomass procurement staff for each biomass facility will offer to pay only the present market price and not attempt to obtain residue now being used by other firms. In other words, they will increase the supply of biomass (shift the supply curve to the right) by purchasing tree-length pulpwood when unused residues are no longer available.

Sites for Small Plants

The required biomass can be obtained at less cost at Perryville than at Marlow. The biomass cost comparison for the two small areas shows a $95,000 annual difference.

Estimated Biomass Cost

Location	Annual Cost of Delivered Biomass
Perryville	$475,000
Marlow	570,000
Difference	95,000

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Therefore the Forest Industry Development Project personnel recommend giving first priority for a biomass plant at the Perryville site, with the Marlow site receiving second priority.

Sites for Large Plants

The required biomass can be obtained at less cost at Mulberry Creek than at Watts Bar; thus, the Mulberry Creek site should receive first priority. The biomass cost comparison for the two large areas shows an annual $346,000 difference.

Estimated Biomass Cost

Location	Annual Cost of Delivered Biomass
Watts Bar	6,286,000
Mulberry Creek	5,940,000
Difference	$ 346,000

The analysis of the biomass resources of the four sites shows a large plant at the Mulberry Creek site to have a cost advantage over a plant at the Watts Bar site. And a small plant at the Perryville site has a cost advantage over one at the Marlow site.

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Appendix

TABLES

The tables are arranged by site in the following order:

Perryville, Tennessee

Marlow, Tennessee

Mulberry Creek, Alabama

Watts Bar, Tennessee

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Table A. Commercial forest area by county, and by major forest type groups, Perryville, Tennessee, procurement area.

County	State	Softwood	Hardwood	Mixed	All types
		- - - - - - - - - - - - (acres) - - - - - - - - - - - -			
Benton	TN	23,200	139,200	5,800	168,200
Carroll	TN	15,300	132,600	5,100	153,000
Decatur	TN	14,497	115,976	18,639	149,112
Hardin	TN	39,452	162,035	28,180	229,667
Henderson	TN	16,048	134,402	20,060	170,510
Humphreys	TN	2,844	241,740	2,844	247,428
Lewis	TN	1,918	126,588	13,426	141,932
Perry	TN	0	214,548	8,469	223,017
Wayne	TN	31,408	330,992	24,160	386,560
State Total		114,667	1,598,081	126,678	1,869,426
Percent		7.7	85.5	6.8	100.0

Source: TVA and USFS Forest Resource Statistics.

Table B. Total aboveground green weight by procurement area of growing stock and of annual net change.

Procurement area	Biomass Weight (1,000 Tons)			Annual Net Change (1,000 Tons)		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
Perryville, TN	131,115	9,492	121,623	2,913	281	2,631
Marlow, TN	123,594	29,303	94,291	1,885	792	2,092
Mulberry Creek, AL	326,518	73,294	253,224	6,922	1,899	5,022
Watts Bar, TN	240,583	61,087	179,496	4,633	1,265	3,368

Source: Unpublished TVA Biomass Statistics.

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Table C. Industrial residues produced, used, and unused by major species groups, and by type of residue, Perryville, Tennessee, procurement area, 1979.

	Annual Oven-dry Weight (Tons)				
	Bark	Chippable	Shaving	Fine	Total
Produced					
Softwood	111,426	9,849	4,072	6,110	131,457
Hard Hardwood	80,232	100,693	6,068	80,350	267,343
Soft Hardwood	10,593	13,703	1,174	11,756	37,226
TOTAL	202,251	124,245	11,314	98,216	436,026
Used					
Softwood	109,332	6,454	334	1,598	117,718
Hard Hardwood	59,717	83,832	1,713	29,256	174,518
Soft Hardwood	7,737	11,508	781	4,798	24,824
TOTAL	176,786	101,794	2,828	35,652	317,060
UNUSED					
Softwood	2,094	3,395	3,738	4,512	12,739
Hard Hardwood	20,515	16,861	4,355	51,094	92,825
Soft Hardwood	2,856	2,195	393	6,958	12,402
TOTAL	25,465	22,451	8,486	62,564	118,966

ACTIVE PLANTS, 1979: 116

Source: Brooks, R. T., J. D. Perry, and S. J. Byrne. "Production and Use of Industrial Wood and Bark Residues in the Tennessee Valley, 1979" (Norris, Tennessee, April, 1981), 127 pp. TVA Technical Note B45.

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Table D. Commercial forest area by county, and by major forest type groups, Marlow, Tennessee, procurement area.

County	State	Softwood	Hardwood	Mixed	All types
		- - - - - - - - - - - - (acres) - - - - - - - - - - - -			
Anderson	TN	15,296	107,072	21,032	143,400
Blount	TN	48,750	54,375	22,500	125,625
Campbell	TN	26,980	180,766	17,537	225,283
Knox	TN	35,989	67,744	23,287	127,020
Loudon	TN	20,434	32,454	6,010	58,898
Morgan	TN	34,900	219,000	46,500	300,400
Roane	TN	34,400	101,728	16,456	152,592
Scott	TN	39,200	240,800	28,000	308,000
Union	TN	18,297	63,023	12,198	93,518
State Total		274,246	1,066,962	193,520	1,534,728
Percent		17.9	69.5	12.6	100.0

Source: TVA and USFS Forest Resource Statistics.

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Table E. Industrial residues produced, used, and unused, by major species groups, and by type of residue, Marlow, Tennessee, procurement area, 1979.

	Annual Oven-dry Weight (Tons)				
	Bark	Chippable	Shaving	Fine	Total
Produced					
Softwood	89,947	33,849	15,825	18,031	157,652
Hard Hardwood	45,873	99,552	54,764	68,381	268,570
Soft Hardwood	8,185	29,589	8,800	11,378	48,952
TOTAL	144,005	153,990	79,389	97,790	475,174
Used					
Softwood	85,884	26,572	12,912	11,170	136,538
Hard Hardwood	38,257	89,561	46,916	51,648	226,382
Soft Hardwood	6,194	18,174	7,219	7,151	38,738
TOTAL	130,335	134,307	67,047	69,969	401,658
UNUSED					
Softwood	4,063	7,277	2,913	6,861	21,114
Hard Hardwood	7,616	9,991	7,848	16,733	42,188
Soft Hardwood	1,991	2,415	1,581	4,227	10,214
TOTAL	13,670	19,683	12,342	27,821	73,516

ACTIVE PLANTS, 1979: 276

Source: Brooks, R. T., J. D. Perry, and S. J. Byrne, "Production and Use of Industrial Wood and Bark Residues in the Tennessee Valley, 1979" (Norris, Tennessee, April, 1981), 127 pp. TVA Technical Note B45.

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Table F. Commercial forest area by state and county, and by major forest type groups, Mulberry Creek, Alabama, procurement area.

County	State	Softwood	Hardwood	Mixed	All Types
		- - - - - - - - - - - (acres) - - - - - - - - - - -			
Colbert	AL	61,791	136,515	18,681	216,987
Franklin	AL	55,000	145,000	65,000	265,000
Lauderdale	AL	20,804	151,572	10,402	182,778
Lawrence	AL	42,921	131,022	38,403	212,346
Limestone	AL	7,716	84,876	2,572	95,164
Marion	AL	134,695	129,797	102,858	367,350
Morgan	AL	38,085	101,560	22,851	162,496
Winston	AL	125,922	115,767	85,302	326,991
STATE TOTAL		486,934	996,109	346,069	1,829,112
Alcorn	MS	28,384	86,926	23,062	138,372
Itawamba	MS	68,103	139,449	48,645	256,197
Lee	MS	14,600	51,100	21,900	87,600
Prentiss	MS	32,976	75,112	25,648	133,736
Tippah	MS	58,300	68,900	31,800	159,000
Tishomingo	MS	70,210	94,990	37,170	202,370
Union	MS	36,600	24,400	48,800	109,800
STATE TOTAL		309,173	540,877	237,025	1,087,075
Chester	TN	19,719	70,112	6,573	96,404
Decatur	TN	14,497	115,976	18,639	149,112
Giles	TN	9,900	145,200	13,200	168,300
Hardeman	TN	30,000	192,000	-	222,000
Hardin	TN	39,452	162,035	28,180	229,667
Henderson	TN	16,045	134,402	20,060	170,510
Lawrence	TN	6,006	180,180	-	186,186
Lewis	TN	1,918	126,588	13,426	141,932
McNairy	TN	55,692	131,274	19,890	206,856
Perry	TN	-	314,548	8,469	223,017
Wayne	TN	31,408	330,992	24,160	386,560
STATE TOTAL		224,640	1,803,307	152,597	2,180,544
ALL STATES		1,020,747	3,340,293	735,691	5,096,731
PERCENT		20.0	65.6	14.4	100.0

Source: TVA and USFS Forest Resource Statistics.

BEST COPY AVAILABLE

Table G. Industrial residues produced, used, and unused, by major species groups, and by type of residue, Mulberry Creek, Alabama, procurement area, 1979.

	Annual Oven-dry Weight (Tons)				
	Bark	Chippable	Shaving	Fine	Total
Produced					
Softwood	187,943	132,670	76,412	84,354	481,379
Hard Hardwood	155,537	203,547	50,330	148,090	557,504
Soft Hardwood	28,346	36,274	9,591	25,342	99,553
TOTAL	371,826	372,491	136,333	257,746	1,138,436
Used					
Softwood	154,996	111,676	44,509	44,849	356,030
Hard Hardwood	90,510	160,537	26,722	52,262	330,031
Soft Hardwood	16,578	30,082	6,597	9,297	62,554
TOTAL	262,084	302,295	77,828	106,408	748,615
Unused					
Softwood	32,947	20,994	31,903	39,505	125,349
Hard Hardwood	65,027	43,010	23,608	95,828	227,473
Soft Hardwood	11,768	6,192	2,994	16,045	36,999
TOTAL	109,742	70,196	58,505	151,378	389,821

ACTIVE PLANTS: 380

Source: Brooks, R. T., J. D. Perry, and S. J. Byrne, "Production and Use of Industrial Wood and Bark Residues in the Tennessee Valley, 1979" (Norris, Tennessee, April, 1981), 127 pp. TVA Technical Note B45.

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Table H. Commercial forest area by county, and by major forest type groups, Watts Bar, Tennessee, procurement area.

County	State	Softwood	Hardwood	Mixed	All Types
		- - - - - - - - - - - - (acres) - - - - - - - - - - - -			
Anderson	TN	15,296	107,072	21,032	143,400
Bledsoe	TN	23,229	136,793	15,486	175,708
Blount	TN	48,750	54,375	22,500	125,625
Bradley	TN	36,252	32,224	10,070	78,546
Cumberland	TN	42,959	262,276	33,915	339,150
Grundy	TN	12,400	148,800	24,800	186,000
Hamilton	TN	26,076	71,709	32,595	130,380
Loudon	TN	20,434	32,454	6,010	58,898
McMinn	TN	65,568	55,323	24,588	145,479
Marion	TN	5,500	187,000	55,000	247,500
Meigs	TN	34,029	25,074	21,492	80,595
Monroe	TN	104,400	133,400	58,000	295,800
Morgan	TN	34,900	219,000	46,500	300,400
Polk	TN	82,060	74,600	71,616	228,276
Rhea	TN	30,345	80,325	23,205	133,875
Roane	TN	34,408	101,728	16,456	152,592
Sequatchie	TN	36,756	104,142	9,189	150,087
Van Buren	TN	21,304	98,531	7,989	127,824
White	TN	21,200	106,000	-	127,200
TOTAL		695,866	2,030,826	500,443	3,227,135
PERCENT		21.6	62.9	15.5	100.0

Source: TVA and USFA Forest Resource Statistics.

BEST COPY AVAILABLE

Table I. Industrial residues produced, used, and unused, by major species groups, and by type of residue, Watts Bar, Tennessee, procurement area, 1979.

	Annual Oven-dry Weight (Tons)				
	Bark	Chippable	Shaving	Fine	Total
Produced					
Softwood	89,129	21,470	12,265	14,500	137,364
Hard Hardwood	39,087	72,868	46,578	52,637	211,170
Soft Hardwood	5,779	13,828	7,077	7,543	34,227
TOTAL	133,995	108,166	65,920	74,680	382,761
Used					
Softwood	85,054	15,411	11,664	9,772	121,901
Hard Hardwood	32,263	61,895	40,631	41,882	176,671
Soft Hardwood	4,634	12,003	5,641	5,597	27,875
TOTAL	121,951	89,309	57,936	57,251	326,447
UNUSED					
Softwood	4,075	6,059	601	4,728	15,463
Hard Hardwood	6,824	10,973	5,947	10,755	34,499
Soft Hardwood	1,145	1,825	1,436	1,946	6,352
TOTAL	12,004	18,857	7,984	17,429	56,314

ACTIVE PLANTS, 1979: 217

Source: Brooks, R. T., J. D. Perry, and S. J. Byrne, "Production and Use of Industrial Wood and Bark Residues in the Tennessee Valley, 1979" (Norris, Tennessee, April, 1981), 127 pp. TVA Technical Note B45.

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